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TIDAL STRIPPING OF GLOBULAR CLUSTERS

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RESUMEN

Hemos analizado 9 galaxias seleccionadas del ACS Virgo Cluster Survey con el fin de estudiar efectos de marea en cúmulos globulares en galaxias tempranas. Hemos determinado la frecuencia específica S_N como función de la distancia al centro de Virgo. Nuestros resultados indican que S_N tiende a incrementarse a medida que la distancia al centro del cúmulo crece. Sin embargo, cuando analizamos la población de cúmulos globulares azules y rojos, este efecto se observa solamente en la población azul, la cual es típicamente más extendida y por lo tanto, más afectada por interacciones de marea. Estos resultados son interpretados como evidencia de efectos de marea sobre la población de cúmulos globulares debida al potencial del cúmulo y a interacciones entre galaxias.

ABSTRACT

We have analyzed 9 galaxies taken from the ACS Virgo Cluster Survey to study the tidal stripping of globular clusters in early type galaxies. We estimate the specific frequency (S_N) of globular clusters in the cluster galaxies, our results indicate that the mean S_N increases with the galactocentric distance. However, if the blue and red globular clusters populations are analyzed separately, this effect is only present for the blue population, which is typically the most extended and therefore most affected by tidal effects. The aforementioned results are interpreted as evidence of tidal stripping of globular clusters due to both the cluster potential well and galaxy-galaxy interactions.

Key Words: galaxies: clusters: general — galaxies: elliptical and lenticular, cD

1. INTRODUCTION

It has been demonstrated that tidal interaction can strongly affect the evolution of galaxies in clusters. Rapid gravitational encounters (galaxy harassment) as well as the global gravitational field of the cluster itself can dramatically change galaxy properties. Some of the properties that can be affected by tidal forces are those related to the population of globular clusters (GC). Since tidal encounters as well as the global effect of the cluster potential increase towards the inner region of the cluster itself, a positive correlation between the slope of the GC population and the clustocentric distance of the galaxies should be observed. Forbes et al. (1997) find a possible evidence of tidal striping in Fornax. These authors analyze the specific frequency of GC in four galaxies located in the central region of the cluster, and they find a marginal dependence of S_N with the clustocentric distance of the galaxies.

In this work we study the GC population of a sample of 9 member galaxies of the the Virgo Cluster. Data are taken form the ACS Virgo Cluster Survey (Côté et al. 2004). The aim of this work is to detect whether or not there is evidence of the tidal stripping effect on the GC population due to galaxy-galaxy interaction and the potential well of the cluster.

2. SAMPLE OF GALAXIES

The Virgo Cluster (hereafter VC) is a well studied cluster at a distance of 16.5 Mpc, with a velocity dispersion of 776 ± 21 kms, and a intra-cluster gas temperature of 2.4 keV. Côté et al. (2004) observed 100 early-type galaxies in the VC survey using the *Advanced Camera for Surveys* (ACS) on-borad the *Hubble Space Telescope* (HST). These observations not only provide a unique opportunity to study the GC population in the cluster galaxies, but also to study the GC population in the intracluster medium (ICM). However, since the ACS detector has a limited angular size, we have to carefully choose the target galaxies in order to include the whole object and a suitable fraction of the background. Our analysis lead to the conclusion that those galaxies of the Virgo Cluster with a total integrated luminosity fainter than $B_T \leq 12.15$ have apparent diameters significantly smaller than the field of view of the ACS and therefore they are suitable for our purposes. On the other hand, since the GC population

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depends on the host galaxy luminosity and morphology, we have selected an homogeneous set of galaxies. Particularly, we have only chosen elliptical galaxies within the narrowest possible range of total luminosity. Our final sample consists in 9 elliptical galaxies with total luminosities $12.15 < B_T < 14.3$, and clustocentric distances 0.02 Mpc $< r_c <$ 1.50 Mpc. Data reduction follow the same procedure used by Jordán et al. 2004. We use colors in order to divide our sample according to the metalicity: objects with $g_{475} - z_{850} > 1.15$ were considered metal rich (red GC), while GC with $g_{475} - z_{850} < 1.15$ were considered metal poor (blue GC).

3. BACKGROUND DETERMINATION

The observed population of GC is superposed to a background noise that exponentially grows with the apparent magnitude. This background is basically made of background galaxies, foreground stars and a projected intra-cluster globular cluster population. If the tidal striping of GC is an efficient mechanism in clusters of galaxies, a fraction of the ICGCs background can be caused by this effect. Moreover, this background should present a gradient, being higher as the projected distance to the cluster center is smaller.

The bright threshold of our sub-sample of galaxies has been selected in order to assure that the GCs population that is gravitationally bound to each galaxy ends at 1.3′ (or 6.2 kpc) For all the galaxies in our sample we found that beyond this limit, the density profile of GC is flat. GCs at larger distances are used to estimate the mean local backgrounds around the parent galaxy. We have also estimated a mean background at different projected distances of the Virgo center averaging the local background around galaxies in bins of clustercentric distances. VCC1279 and VCC1297 are in projection close to M87 and therefore their local background can be contaminated by the CG population of the cD galaxy. Therefore, for the central region of the VC we only estimate the local background around the two mentioned galaxies. Besides the two galaxies close to M87, no clear dependence of the mean background with the clutercentric distance is present.

4. RADIAL DEPENDENCE OF THE SPECIFIC FREQUENCY

We compute the specific frequency

$$S_N = N_{GC} 10^{0.4(M_V+15)}$$

(Harris & van den Bergh 1981) for the total, red and blue populations of GC for each galaxy in our sample. The number of globular clusters were corrected by background contamination according to § 3.

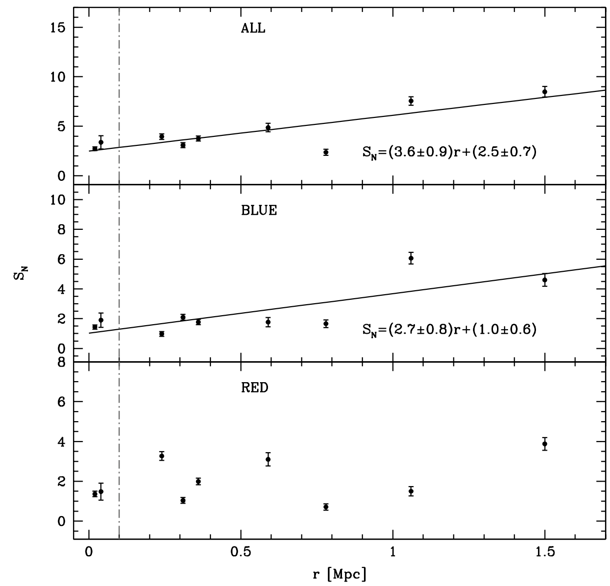

Fig. 1. S_N of each galaxy as a function of the distance to the center of the Virgo Cluster.

The S_Ns can be used to evaluate the possible presence of tidal effects in the globular cluster population. We find a correlation between S_N and the distance of the host galaxy to the center of the Virgo Cluster (r), in the sense that larger values of S_N correspond to larger clustercentric distances (see Figure 1). This result is consistent with a decrease of the number of GC in the outskirts of the galaxies as a function of the clustercentric distance, and it is also consistent with the idea that tidal stripping more affects the GC population of those galaxies located in the core of the Virgo cluster. The correlation is only present for the blue population. This effect can be explained by the fact that red GC are more concentrated and therefore less affected by tidal effects. It should be noted that the clustercentric distances considered in this work are a projection of true 3-D distance to the Virgo cluster center. Therefore, this projection is responsible of a fraction of the scatter found in the correlations presented in this work.

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